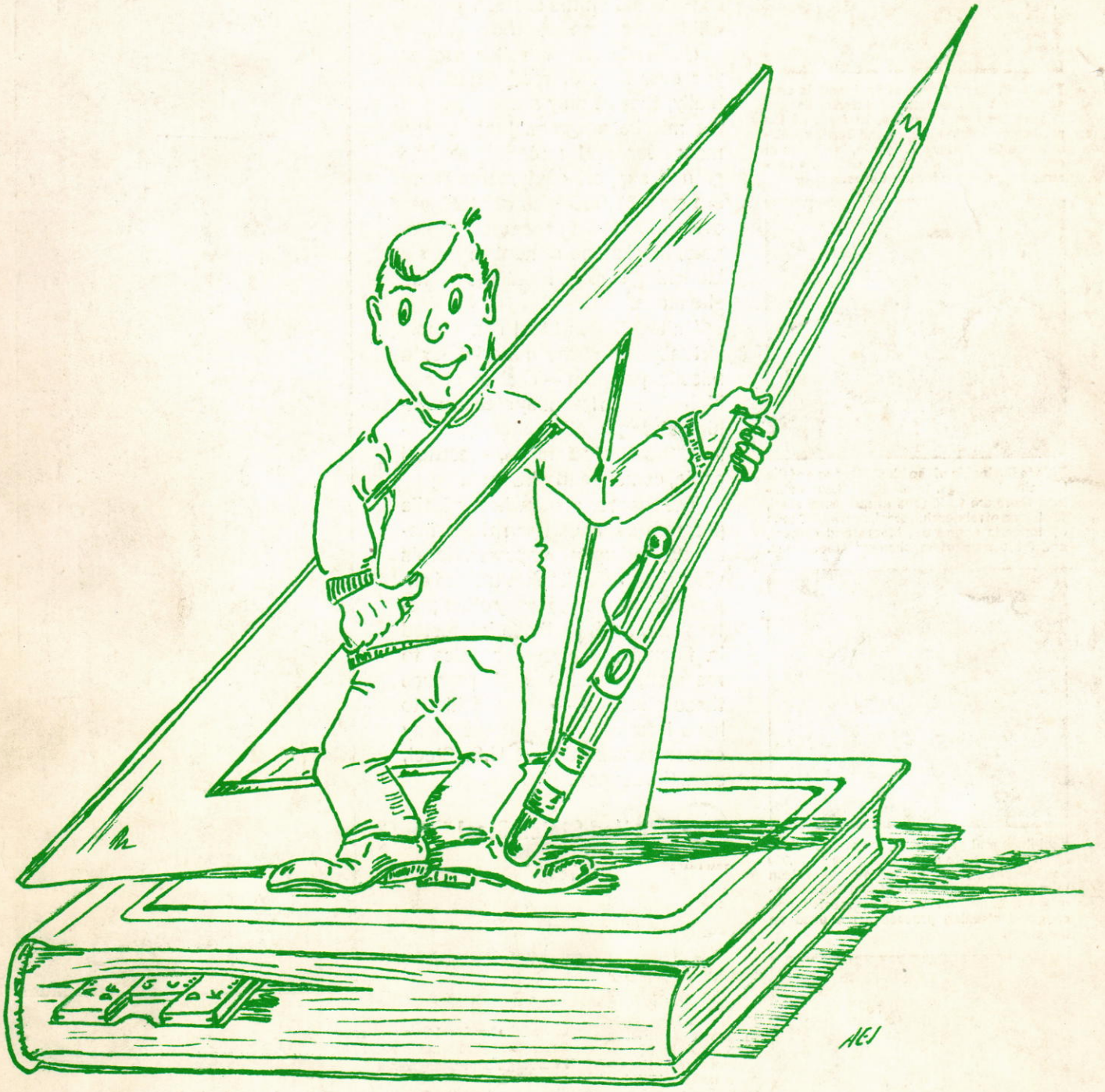
the Mecheleciv

VOL. 19 OCTOBER 1960 NO. 1

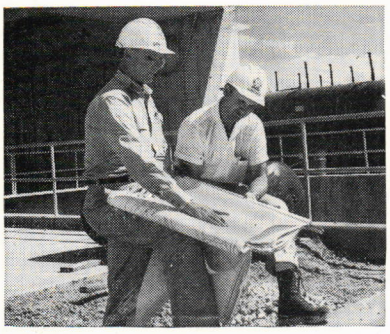
THE GEORGE WASHINGTON UNIVERSITY ~ SCHOOL OF ENGINEERING ~



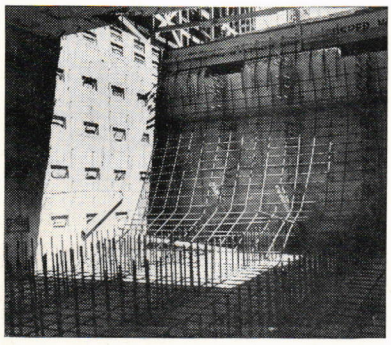
THE GEORGE WASHINGTON UNIVERSITY

October 1960

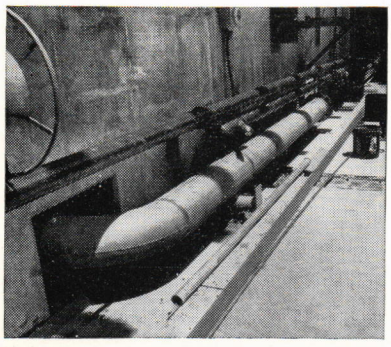
Somewhere east of Laramie, on one of Wyoming's plains, you'll find the strangest government housing project ever built. Six concrete and steel buildings are being constructed to house Atlas missiles. The site is one of the operational intercontinental missile bases to be operated by the Strategic Air Command. This base is being constructed on the surface. Others will burrow deep into the earth.



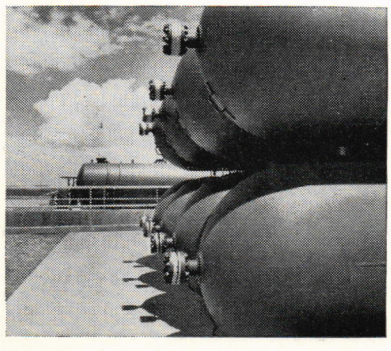
The U. S. Army Corps of Engineers is constructing this operational intercontinental missile base in Wyoming. In front of the partially completed Launch and Service Buildings are Col. Sidney T. Martin, in charge of construction, and Maurice K. Graber, a construction engineer for the Corps.



This is the inside of the blast pit of one of the launcher buildings. In all six of these buildings there are 1,040 tons of structural steel, 1,950 tons of reinforcing steel, over 48,000 tons of concrete aggregate, blocks and cement, and 8,040 tons of mechanical steel items.



Fuel lines and process piping are Stainless Steel and operate at pressures up to 15,000 psi. The pipes are kept almost surgically clean to prevent contamination of fuel and subsequent malfunction. Vapor degreasing and chemical cleaning processes are used on the pipes.



The Atlas is powered by a cluster of liquid propellant rocket engines that burn liquid oxygen and RP-1, a kerosene-like hydrocarbon fuel. 192 pressure tanks fabricated from alloy or Stainless Steel plate at this site store liquid and gases —liquid oxygen and nitrogen and helium gases which are used to inject the fuels into the missiles.

Generally, the missiles are all you ever hear or read about. Actually, they're only a small part of the missile program. Most of the manpower and material go into ground support equipment. There are over 11,000 tons of steel and over 48,000 tons of concrete aggregate, blocks and cement in the six launching service buildings at this site alone.

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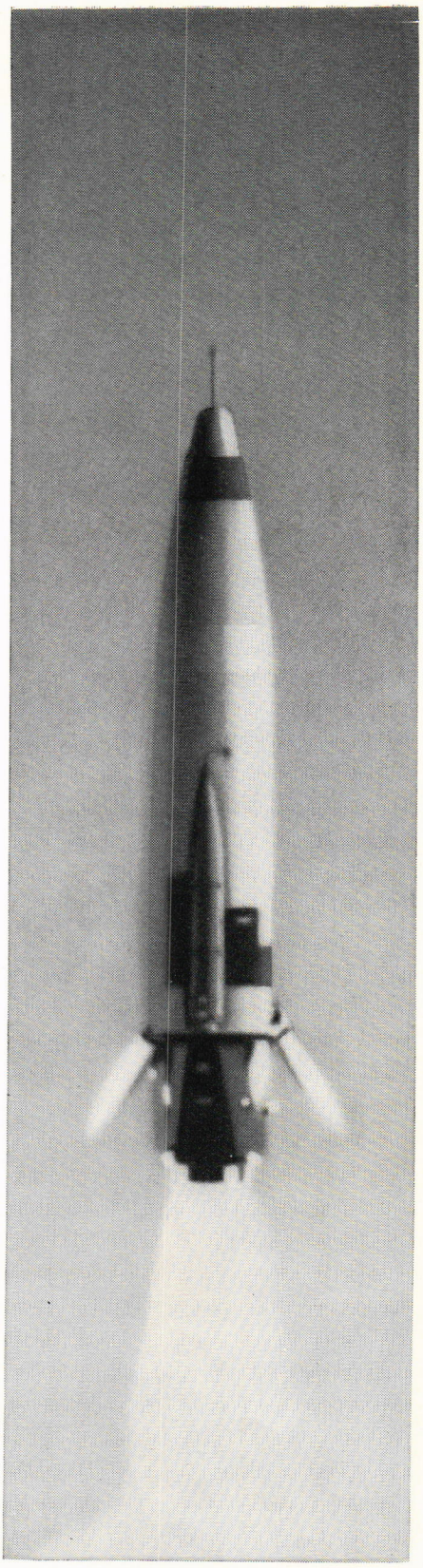

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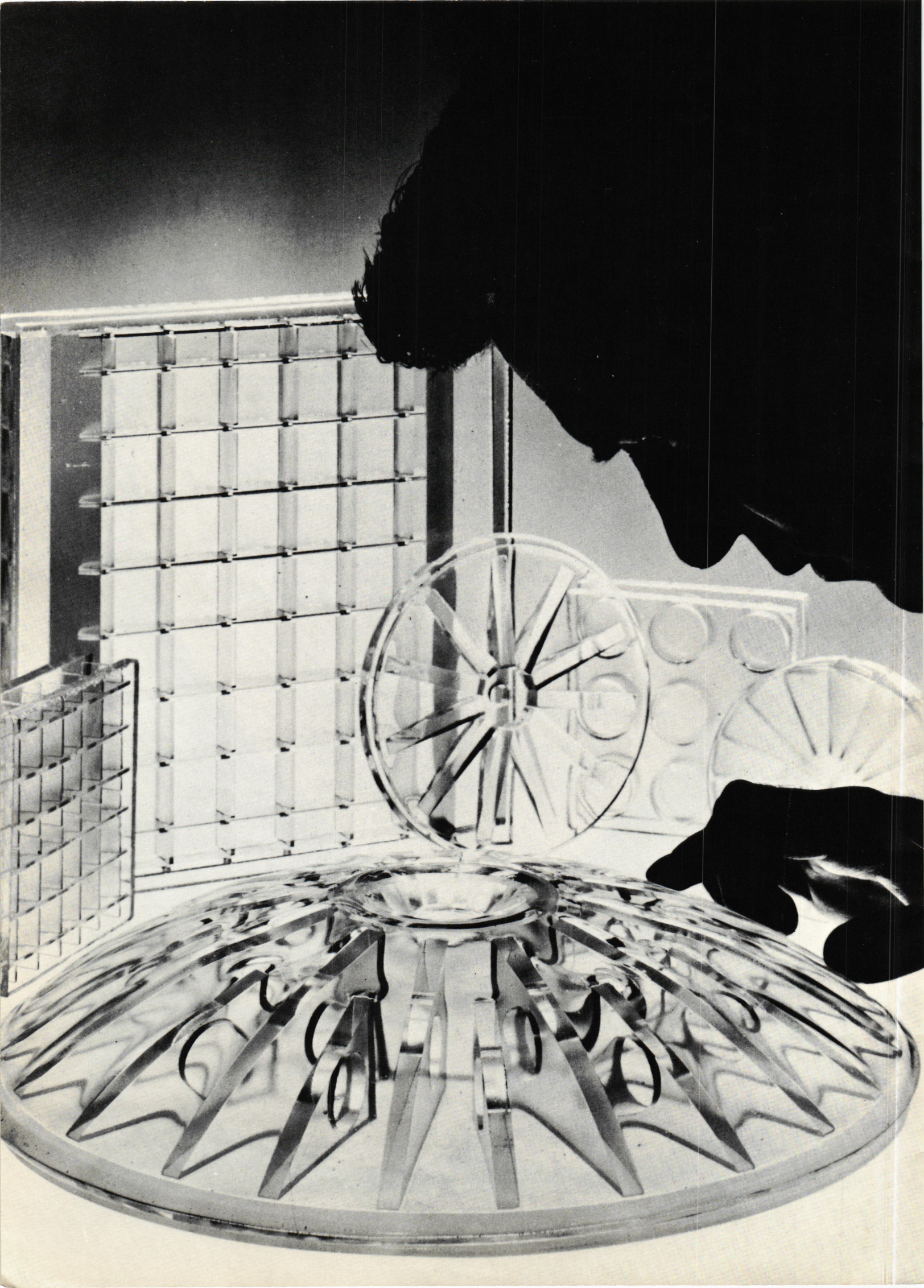

the Mechelecіv

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ARTICLES

DEPARTMENTS

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Editorial Page

WHAT'S AHEAD?

Will Rogers once said, "Everybody is talking about the weather but nobody's doing anything about it." So it is with the new decade. Everybody is talking about educational standards, teacher's pay and the dignity of intellectual and engineering professions; but the precious few who are dedicated to raising these standards, and who plead endlessly for the support of their cause can do but little.

The flood of students supposed to begin pouring into our colleges in the next couple years will generate the need for mass teaching techniques. Educational expansion at a normal rate, with no regard for an accelerated population and technology, can result in nothing but mass techniques. Student-teacher relationships may be in terms of numbers on a punch card. Several large classes may be taught simultaneously by one instructor using closed circuit TV.

Are we to believe that this system will meet the needs of education in the '60's? Objectively, an up-dated system requires that we raise the educational standards of our students and the dignity of our educators. An up-dated system also requires inspired and inspiring teachers, who when given encouragement in their efforts for self development, respected and honored for their devotion, reveal to their students the glory of creative minds. Another extremely important task of the teacher is to seek out the students who can be taught to appraise and evaluate, and to cultivate in that student a devotion to creative thought. These tasks can never be accomplished through the inevitable closed circuit TV and punch card student-teacher relationships where the only possible objective is quantity.

In our country the highest salaries are gleaned in Hollywood, while the USSR's highest salaried person is the President of the Soviet Academy of Sciences. Senior professors, scientists and top engineers in the USSR are paid a wage 6 to 10 times the average industrial wage, equivalent in this country to $25,000 to $40,000 a year. Today, however, in the United States our interests in intellect is at a disgraceful ebb. We have dignified our scientists, professors and engineers by such names as "egg-heads" and "long-hairs" standing before a blackboard, pointer in hand, mortor-boards askew and displaying a vacant look on their faces.

With the ever increasing demands for higher educational standards imposed by today's dynamic technology, coupled with an overwhelming influx of students, you bet we are facing a crisis in education in the 60's! What hope can there possibly be to raise the dignity of the teaching, scientific, and engineering professions when they have lost their identity en masse.

Successful Shot Orbits Courier Satellite

Edited by John Wolfgang

A strictly utilitarian satellite, designed for military global communications, was developed by Philco Western Development Laboratories, Palo Alto, California, for use by the Department of Defense. Named Courier, the satellite will provide to ground stations a microwave communications link. This type of station is in the form of an unstabilized earth satellite operating at an altitude of approximately 600 miles.

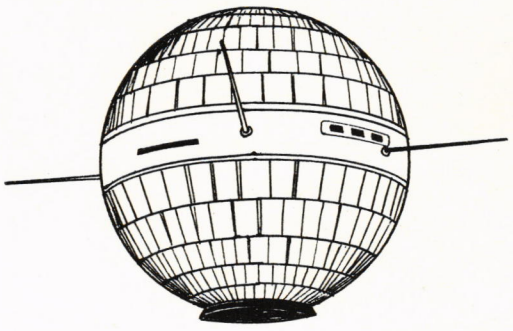
The primary mission of the Courier Satellite Communications System is to provide the equivalent of twenty continuously available 100 wpm teletype channels at strategic points throughout the world. It can also be used for "real time" transmission . . . instantaneous retransmission of a message to any other ground station visible to the satellite. This transmission facility is capable of integration with existing and proposed global communication networks.

A self-sufficient space age courier, the Army satellite has a built-in power source consisting of about 20,000 solar cells, it has built-in circuitry which rejects any command or query not properly coded, and through redundant components carries spare parts for repairing itself.

Spherical and about twice the size of the Tiros satellite, Courier's ornamental appearance belies its workhorse capabilities; its surface faceted by the thousands of bluish, highly reflective solar cells covering most of its area, it outwardly has little in common with typical, olive drab military communications devices. Only the antennas, protruding from a white band around its middle, give it a functional look.

Reliability is a prime requirement set by the Department of Defense, and to achieve the required reliability for a system as complex as Courier nearly half the allowable weight and space was alloted to spare equipments. The spares in most cases therefore were to be switched into the system by ground command if failures occurred. Ultimate satellite models evolving from the long range developmental program, under sponsorship of the Advanced Research Projects Agency, will have a 90% probability of remaining operational for one year.

The precision of control over the satellite's various equipment was made possible by its built-in digital logic system, called the command decoder. Designed to use standardized logic modules, the command decoder checks all incoming signals and commands with regard to procedural correctness, signal strength adequacy, and compatibility with the satellite's functioning at that instant. It routes any acceptable command to the appropriate equipment and then initiates a coded acknowledgment signal which is transmitted back to the ground station.



The satellite is expected to orbit the earth approximately every 110 minutes or 14 times a day. However, it will be visible to the ground stations only during an average of 10 of these orbits, during which time it can engage in message traffic. While between ground stations, it will transmit a beacon tone, to aid in acquisition. When acquired by a ground station, it can be commanded to record a message and to simultaneously transmit messages recorded at previous stations.

The effective instantaneous rate of data transmission of the Courier satellite is 55,000 bits per second of incoming traffic, plus the same amount simultaneously outgoing. The average traffic handling capacity of the Courier system depends at present on the number and location of ground stations with respect to a given set of orbital parameters, and also on the average output of the satellite's power system.

Microwave Communications Subsystem: The Microwave communications subsystem is comprised of four microwave transmitters, four microwave receivers, a baseband combiner, five data-storage tape recorders, microwave antennas, and diplexers. Two microwave antennas with hemispherical radiation patterns are located on the equatorial band of the satellite. Two independent transistorized FM receivers are connected to each antenna through the diplexers and R.F. cables. The receiver noise figure is less than 12 db. Each receiver weighs 6.4 lbs. and requires 3.3 watts of primary power. The video baseband outputs of the four receivers are combined in the diversity combiner. The signal-to-noise ratio of each receiver output is measured, and the outputs

—Continued next page

are combined proportionally to their signal-to-noise ratios. The baseband combiner also serves as a fail safe switching element for the receivers. If one of the receivers connected to each antenna fails, the system will still perform without loss of signal. The baseband combiner weighs 3.4 lbs. and requires 800 milliwatts of power input.

Four Microwave FM transmitters are included in the satellite. To avoid undue complexity in switching, the transmitters are operated in pairs, with each transmitter of the pair connected to one of the Microwave antennas. The other two transmitters are included to serve as redundant spares to be used in the event of a transmitter failure.

The design of the transmitters is unique in that except for the final power amplifier tube, the transmitters use solid state active circuit elements. Frequency stability over the environmental temperature range is assured by the use of a crystal controlled reference oscillator circuit which operates an electro mechanical frequency control system. Pressure sealed cases are used to insure reliable operation of the electro mechanical elements in the high vacuum orbital environment.

Each transmitter weighs 26 lbs. and requires less than 80 watts input for an R.F. power input of 7 watts.

Five tape recorders are used in the Courier satellite. Recorders may be assigned to existing ground stations with remaining units serving as redundant spares. Four of the recorders are designed to store teletype digital communications data. The fifth recorder will be used to test the system capability with analog or voice information. Data can be read into, or out of, each recorder for five minutes.

The tape recorders were developed for Philco by Consolidated Electrodynamics Corportation of California.

Each recorder weighs 5.6 lbs., and consumes approximately 10 watts.

Telemetry Subsystem: A PAM/FM/FM telemetry system has been provided to evaluate the performance and environmental condition of the Courier satellite. An all transistorized telemetry generator has been developed by Philco to commutate 26 system parameters, such as equipment temperatures and equipment performance, such as receiver signal-to-noise ratios, transmitter power outputs and power system voltage and current. In addition, the telemetry system transmits verification of commands to the ground station.

The various telemetry sensors, the telemetry generator and redundant 1.5 watt FM transmitters comprise the telemetry subsystem. All active circuit elements in this subsystem are solid state devices.

The commutated data modulates six subcarriers which in turn frequency modulate the telemetry transmitter. A seventh subcarrier is used for timing purposes. The total weight of the telemetry generator 21 lbs., and it requires 4.6 watts during normal operation. The FM VHF telemetry transmitters are of an advanced transistorized design. Parallel VHF power transistors are used to supply 1.0 watt power output under all environmental conditions. The 24 cubic inch package weighs one lb. and requires 5.6 watts of primary power.

The telemetry transmitter power is radiated from four whip antennas located on the equatorial band of the satellite. A VHF diplexer is included to permit simultaneous VHF Transmitter and VHF Receiver operation.

Command Subsystem: The command subsystem serves as the "switch board" for the microwave communications and telemetry subsystems, as a clock to synchronize certain satellite functions, and in addition has the "repairman" function of switching between certain of the equipment in the satellite. The command subsystem is comprised of redundant VHF receivers and a command decoder which in many respects is comparable to a small scale digital computer.

Over 500 transistors and 700 semiconductor diodes are used in the command decoder. The decoder performs many logical operations on the command data which ensure that erroneous commands are not accepted, and reduces the probability that deliberate or accidental interference will cause a loss of communications data. The command decoder uses logic circuits which are the result of extensive design experience and testing to insure reliability of operation.

Commands are delivered to the decoder from two all transistorized, crystal controlled FM command receivers. A unique method of receiver cycling and switching is used to conserve power and utilize the redundant receivers to the greatest extent. Each receiver weighs 2 lbs. and requires 530 milliwatts of power.

VHF Beacon: The Courier satellite has a 50 milliwatt transistorized VHF transmitter subsystem. Redundant transmitters are used to increase system reliability. One of the transmitters is left operating when the satellite is not

--Continued page 16

Thermoelectric Materials: Key to Power Generation

Edited by Larry C. Hice

Introduction

Almost 150 years ago the German physicist Thomas Seebeck discovered that the flow of heat through a metal segment could produce a voltage difference between its hot and cold ends. Although this Seebeck effect has since become familiar through its uses in instrumentation, the field of application has been severely limited because of its low voltage and power output.

Quite recently, the development of new thermoelectric materials has made it possible to raise both the power output and the efficiency of thermoelectric devices to levels suitable for the practical generation of power. A year ago, for example, devices were limited to a power output of slightly over 1 watt; compared to generators today rated at 100 watts and very soon construction of a generator rated at 5000 watts will be completed.

The qualities of thermoelectric devices that have impelled these developments, particularly for military applications, include ruggedness and compactness and, of course, the fact that the devices are mechanically static. (That is, heat is converted into electricity without the need for any moving parts.) This freedom from moving parts has several significant implications for defense; for example, in military power plants heat could be converted to electricity without noise. In space vehicles and missiles, the absence of rotating parts would eliminate the gyroscopic forces that occur in rotating machines and so simplify guidance and stability in orbit. As more basic advantages still, the absence of moving parts means that thermoelectric generators are inherently more reliable than rotating machines and perhaps may eventually prove lower in first cost.

The Basic Phenomenon

In any uniformly heated pellet of thermoelectric material its positive and negative electrical charges are uniformly distributed, as in Figure 1 (a), but when heat is applied to one surface, this distribution is no longer uniform. Although the positively charged ions in the crystals remain fixed, the negatively charged electrons tend to move to the cooler end, as in Figure 1(b). This results in a gradient of electrical charge and a potential difference between the hot and cold ends which can cause current to flow in an external load. In practice thermoelectric devices are arranged in an array of series-connected thermocouples whose materials have been so formulated that their voltages are additive. It is through stacking of elements in arrays that we are able to achieve voltage outputs adequate for power generation.

Materials and Their Parameters

One of the most important factors in the growth of thermoelectric technology is the ability to adjust the number of free electrons in semiconductor materials. The importance of this is due to two basic relationships: First, the output voltage of any thermoelectric material is inversely proportional to the number of free electrons in that material; and, second, the conductivity of the material is directly proportional to the number of free electrons. Thus, insulators containing 10^{10} electrons per cubic centimeter generate Seebeck (output) voltages in the order of 10,000 micro-volts per Centigrade degree of temperature difference between the hot and cold ends; unfortunately though they have an extremely high internal resistance. On the other hand, the metals give Seebeck voltages of about 5 microvolts per degree but have extremely low internal resistance. To obtain maximum power output or optimum efficiency from a thermoelectric material the electron density must be adjusted for an acceptable compromise value between high voltage and high electrical conductivity. This is essential to the

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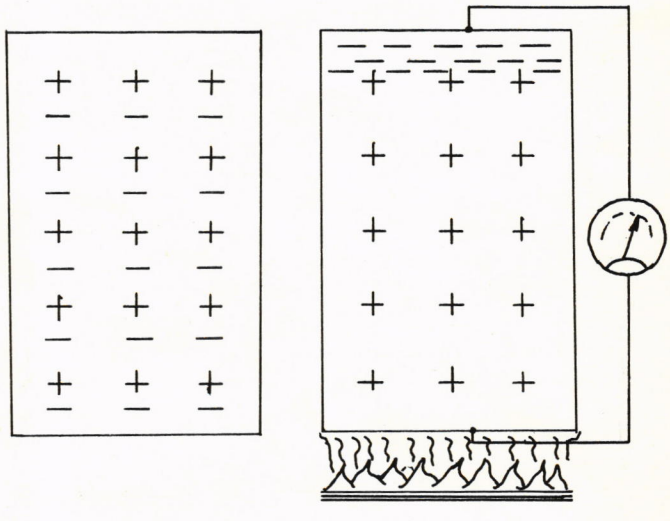

Figure 1

production of useful power since a combination of high voltage and low current or of low voltage and high current result in little power. The compromise is shown by the efficiency curves in Figure 2 which show the optimum electron density to be about 10^{19} free electrons per cubic centimeter, and one which affords Seebeck voltages of about 175 microvolts per degree C. Some typical materials which demonstrate acceptable efficiency are zinc antimony, lead telluride, bismuth telluride, and germanium telluride.

In thermoelectric generators built for practical uses it is desirable to use a number of different thermoelectric materials to assure that each has its best range of operating temperatures. This contributes to the increased efficiency that is possible when generators are operated at high temperatures. To cover low temperatures, say up to 600 degrees C, several semiconductors have proven satisfactory. However, to go higher, say into the 1000 degree C range, semiconductors are no longer suitable since at these temperatures they become "intrinsic"; that is, the heat input causes both positive and negative electrical charges to migrate in equal numbers and so no output voltage is possible.

A promising step is the use of insulator materials which have been modified to become good thermoelectric materials. This is particularly interesting since many insulators exist which do not become intrinsic conductors in the 1000 degree C range. As an illustration of this modification, pure nickel oxide is normally an insulator but if it is modified by the addition of three percent of lithium, its resistivity decreases to about 0.01 ohm-centimeters. As explanation for this, in normal nickel oxide the nickel has a valence of plus two but the addition of lithium causes the appearance of nickel with valence of plus one. The material's greatly increased conductivity is brought about by an exchange of charges between plus-one nickel and plus-two nickel. It is through similar modifications that other materials are being developed for use at higher temperatures. (This approach led to one of our newest mixed valence materials, samarium sulphide, which has a good figure of merit at temperatures as high as 1100 degrees C.)

Devices and Design

Despite these developments, our increasing knowledge of semiconductors or mixed valence materials does not solve all problems of thermoelectricity for after all, materials are not an end in themselves; they must be fabricated as thermocouples and then be assembled in finished devices. Assemblies of thermoelectric materials must be joined so that contact resistance will not be excessive for this would have the same effect as high internal resistivity of the material and would reduce the efficiency. Also, above 300 degrees C, it is necessary for thermoelectric materials to be shielded from the air to prevent corrosion of materials and joints. Another aspect of design is the need to mount thermoelectric devices so that they will withstand shock and vibration.

Turning now from the design of thermocouples to the design of complete generators, we are able to draw some interesting conclusions regarding the relationship between power and weight in equipment of the near future. One of the first generators to be built, produced 100 watts from a 50-pound unit cooled by free convection, for a power-to-weight index of two-to-one. Since performance can be improved considerably by using forced convection of air or water to reject heat, it may be feasible for generators to be designed to produce 15 watts per pound of weight, for a power-to-weight index that is comparable to that for a typical, gasoline-powered 500-watt generator.

Other design problems with high priority grow out of the need to narrow the gap between the efficiency that is theoretically available from known materials and the efficiency that is actually available when these materials are used in equipment. Materials available today are capable of an efficiency of about 17 percent but when assembled as elements of complete generators, the over-all efficiency drops to 6 percent. Much of this loss of efficiency is due to such factors as the stack losses represented by the discharge of heat-bearing gases from the generator's "chimney" and the fact that some of the energy transferred through the walls of the chimney passes around but not through the thermoelectric elements.

Although continued progress in generator design will reduce losses and increase total efficiency, it seems certain that nuclear reactors will be much more efficient in thermoelectric applications than conventional heat sources. With nuclear reactors, it will be possible to have the heat source completely surrounded by thermoelectric elements to eliminate stack losses!

One of the most interesting aspects of the efficiency of thermoelectric generators is that it is independent of power rating, which is, of course in contrast to the power-efficiency relation for conventional machines. Small conventional power supplies have an efficiency of roughly 5 percent, the automobile engine is about 15 percent efficient, and large diesel engines

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WHAT'S NEW?

INSTANT PIPE

Construction machinery that builds "instant concrete pipe" in a freshly-cut ditch at a rate of eight to twelve feet a minute has been developed by Fullerform Continuous Pipe Corp. Inflatable rubber and fabric forms, designed by Goodyear Aircraft Corp. engineers from blimp-type materials, are part of the continuous-operation system. The patented process eliminates joints and seams, cuts construction time and overall costs.

Developed over the past nine years, the construction process consists mainly of a double-hoppered forming machine that is pulled along the rounded bottom of a ditch, while enveloping an inflated inner form. Currently being used to build conduits for irrigation water on farms near Phoenix, the construction process is being adapted to build storm sewers and other types of concrete pipe.

Using two 300-foot inflated forms with only three pounds per square inch of air pressure, as much as 600 feet of concrete pipe can be poured at a time without interruption. It is possible to line up forms for runs in miles. Ready-mix concrete trucks are used in the continuous stream to service the pouring equipment.

The inflatable "inner" form is picked up by the "outer" form so tamping devices can literally tuck concrete under it. Half of the double hopper, activated by electrically driven tampers, forces concrete into the bottom of the ditch, while the other half forms the top of the pipe.

The hose-like, inflatable form, constructed of two plies of cotton fabric coated with neoprene rubber, is open at both ends to hold airtight bulkheads through which air pressure is applied for strength. The inflatable form is easy to handle and can be deflated for extraction about two hours after the concrete has been poured. This makes possible use of the same form several times a day.

Machinery containing the "outside" form for the concrete pipe is set in the ditch and one end of the inflatable form is passed through it. As concrete is poured into the machine's double-hopper, the forming machine is drawn forward by a cable on a winch. An electrically operated tamping device on the top of the machine distributes concrete uniformly and tightly around the inner form.

Commercial work on irrigation pipe was started about a year ago on Arizona farms and ranches. Research and development activities accompanied every commercial venture. Finally, Arizona Testing Laboratories found the system and the finished products would meet Bureau of Reclamation standards for Arizona. The concrete conduit, made with the first inflatable-deflatable pipe form, exceeded bureau weight-test requirements of four tons and compression strength by 520 pounds per square inch.

An inflatable rubber and fabric hose-like concrete form is the key to a new patented process for pouring concrete pipe at a rate of eight to twelve feet a minute.

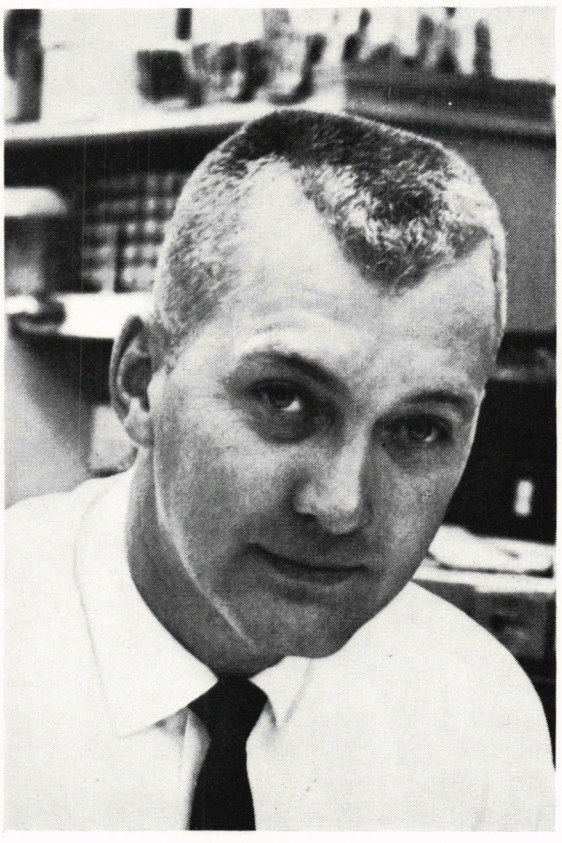
Mecheleciv Staff

MECH MISS

Liz Winslow

Our "Mech Miss" for October is Miss Elizabeth Winslow. She is a Junior College sophomore with a major in Foreign Affairs. "Liz" is 18 years old and is endowed with red hair, hazel eyes and lots of womanly features. Miami, Florida claims to be her birthplace and she has traveled throughout the States and to the Far East. Her interests lie in music, the theater, swimming, riding and good food. Upon graduation she plans to enter the Foreign Service and eventually to attend the University of Geneva.

PROGRAMMING **DEVELOPMENT** **MANUFACTURING**



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CAMPUS NEWS

AIEE - IRE

During the October 5 meeting of the AIEE-IRE, Mr. Brode of Shrader Sound Co., aided by Mr. G. E. Pray, vice-president of Ling-Temco, gave a demonstration-lecture on high-output vs. low-output sound systems and their uses. In his talk, Mr. Brode outlined several different conditions under which a public address system could be used and itemized under each the circumstances that must be considered when choosing and installing a sound system.

The next meeting, on December 9, will feature a talk by Mr. William Hocking on the digital recording system which was designed and built by the National Aeronautics and Space Administration. The purpose of this system is to enter satellite tracking information on perforated tape.

ASME

The student chapter of the ASME held its first meeting on Wednesday, October 5. Professor Dedrick, the chapter's faculty adviser, was the speaker of the evening. He spoke on the effects of environmental pollution and speculated on future advances in solving pollution problems.

The committee chairmanships for the coming year are as follows:

Program Committee: Arthur Macurdy
Publicity Committee: Ann Atkins, Jerry Edwards
Refreshment Committee: Stu Natof
Mecheleciv Representative: Dan Mulville

Student papers for the Mecheleciv will be accepted at the next ASME meeting. Five dollars will be awarded to each student who has his paper published.

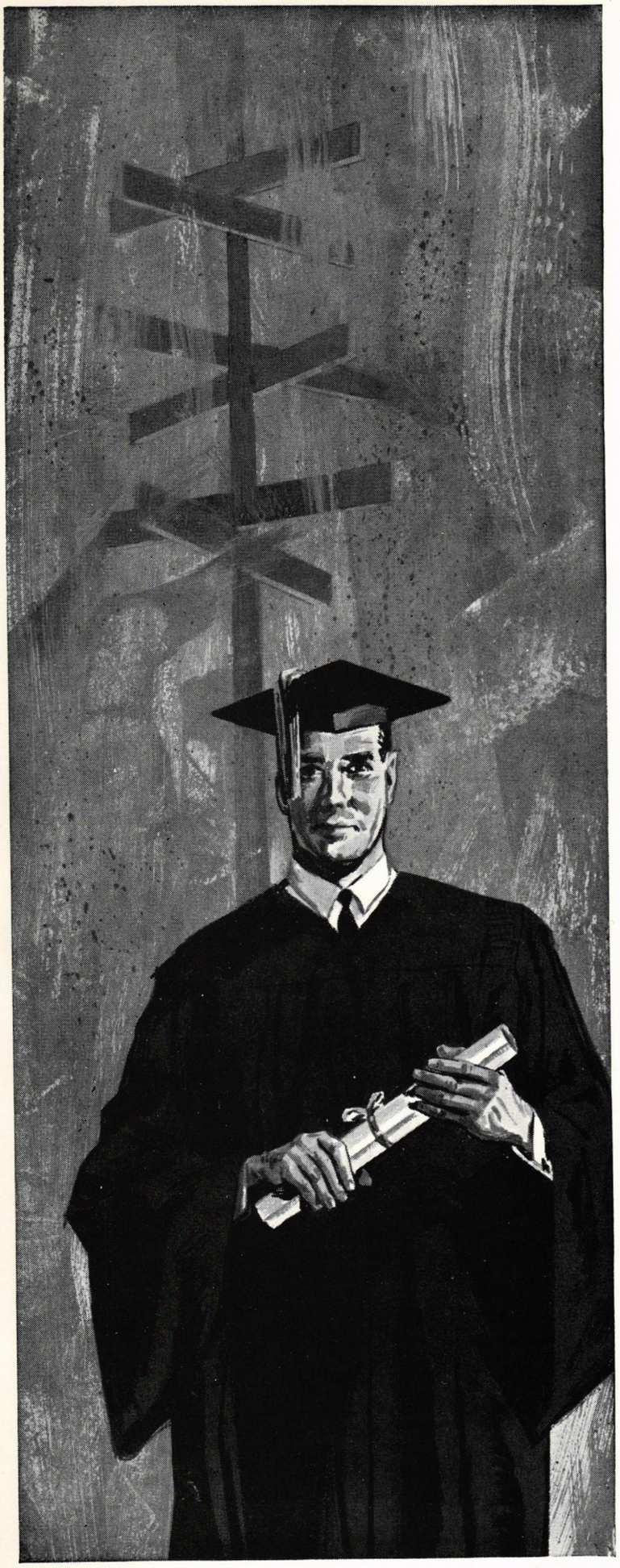
ASCE

Col. Frederick G. Clarke, Engineer Commissioner of the District of Columbia, spoke at the opening meeting of the ASCE on October 5. The topic of his talk was urban development in the next decade. This meeting was held jointly with the Associate Member Forum of the ASCE.

Howard Hill, program chairman, presented to the society proposed topics for future meetings. The prospective topic for the November meeting is city planning.

Officers for this year are as follows:

President: Fred Hood
Vice President: Floyd Mathews
Secretary: Howard Hill
Corresponding Secretary: Bob Krehbiel
Treasurer: Wes Harris



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Freedom of Opportunity opens the doors to challenging and interesting careers. Among them is our Nuclear Power Division, with an engineering staff in Washington, D. C., a new research and development center in Greendale, Wis., and an important research effort at Princeton University involving power from the hydrogen atom. For details on the opportunities available, write to Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.

A-1192

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in active use to permit the ground station to determine when the vehicle comes over the horizon. The beacon is capable of providing tracking signals to the Minitrack stations to assist in determining the orbital parameters of the Courier. Each beacon transmitter weighs 6 ounces and requires 480 milliwatts of primary power.

Primary Power Subsystem: Approximately 20,000 silicon solar cells are fastened to the surface of the Courier satellite. These semiconductors convert solar energy into electrical power to operate the electronic equipment within the satellite. Solar cells are soldered into "shingles" comprised of seven cells each. Twelve shingles are connected in series and attached by adhesives to a curved fiberglass base, or array, which is in turn fastened to a hemispherical cover of the satellite. These arrays are connected in parallel to form the complete solar battery. An optically coated glass cover plate is cemented to each solar cell to improve the efficiency of the cell. The cover plates reflect the portion of the solar spectrum which does not contribute to the electrical energy conversion, and provide additional passive temperature control for the solar power unit.

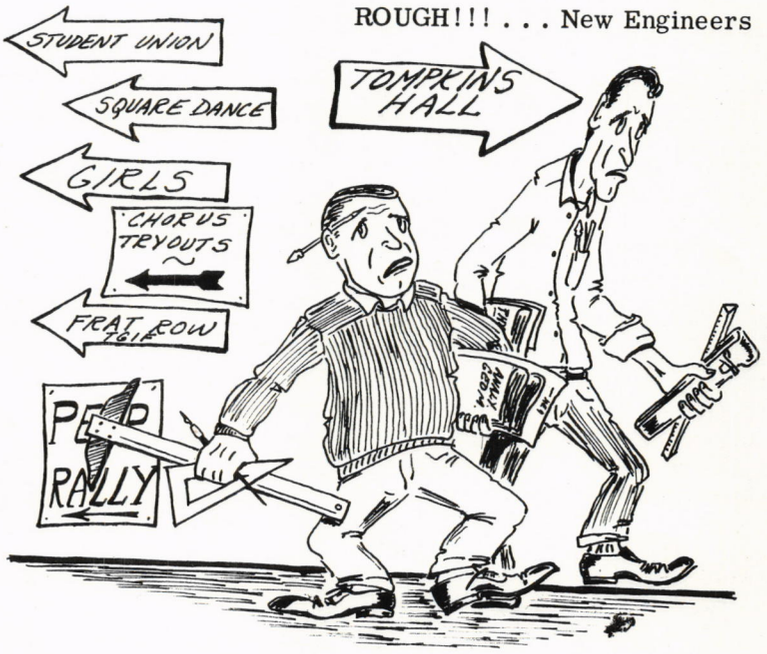
Two separate and independent sets of solar arrays are provided on the Courier. Each one charges a nickel cadmium storage battery which permits higher peak power loads than the solar arrays can supply.

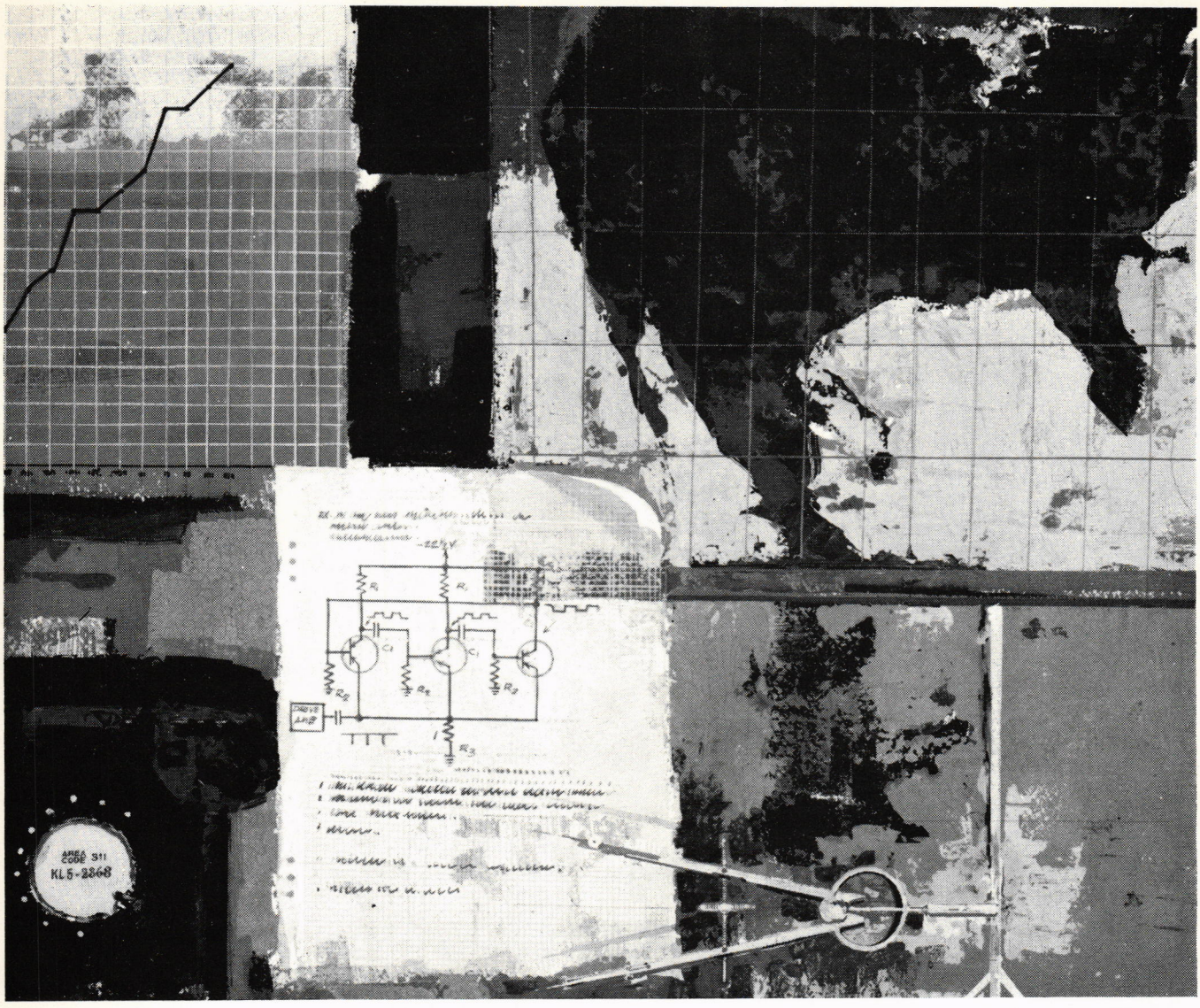
The batteries also provide a means whereby the satellite can operate when it is in the earth's shadow. The nickel cadmium batteries are capable of operating in a free fall, or "weightless" environment. Unlike several of the early short lived satellites which relied on storage batteries alone, the Courier is capable of operating for periods measured in years rather than days or weeks, because of the nature of its power system.

A low voltage sensing device is included in the power system to prevent inadvertent damage to the batteries in the event that excessive power drain occurs.

Structural design and thermal control: A welded aluminum tube frame forms the major structural element of the satellite. A sheet metal band on the "equator" of the structure provides mounting space for the VHF and microwave antennas, and umbilical connectors. The outer shell functions as a support for the solar cell arrays and as a shield for heat control and meteorite erosion. The design consists of two lightweight hemispheres joined together at the inner structure equatorial band with detachable fasteners to establish a form which is approximately spherical in shape. Each hemisphere is fabricated from a plastic honey-comb sandwich between two thin skins of fiberglass epoxy. The "black boxes" and interconnecting cables are mounted on three cellular fiberglass shelves within the sphere. In addition to providing a convenient mounting surface for the equipment, these shelves further control the environmental temperature of the equipments.

ROUGH!!! . . . New Engineers





8,000 Management Opportunities!

That's right. There will be *8,000 supervisory jobs* filled from within the Western Electric Company by college graduates in just the next ten years! How come? Because there's the kind of upward movement at Western Electric that spells *executive opportunity*. Young men in engineering and other professional work can choose between two paths of advancement—one within their own technical field and one within over-all management.

Your progress up-the-ladder to executive positions will be aided by a number of special programs. The annual company-wide personnel survey helps select management prospects. This ties in with planned rotational development, including transfers between Bell Companies and experience in a wide variety of fields. Western Electric maintains its own full-time graduate engineering training program, seven formal management courses, and a tuition refund plan for college study.

After joining Western Electric, you'll be planning production of a steady stream of communications products—electronic switching, carrier, microwave and missile guidance systems and components such as transistors, diodes, ferrites, etc. Every day, engineers at our manufacturing plants are working to bring new developments of our associates at Bell Telephone Laboratories into practical reality. In short, "the sky's your limit" at Western Electric.

Opportunities exist for electrical, mechanical, industrial, civil and chemical engineers, as well as physical science, liberal arts, and business majors. For more information, get your copy of *Consider a Career at Western Electric* from your Placement Officer. Or write College Relations, Room 6105, Western Electric Company, 195 Broadway, New York 7, N. Y. Be sure to arrange for a Western Electric interview when the Bell System team visits your campus.

Western Electric

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Principal manufacturing locations at Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Winston-Salem, N. C.; Buffalo, N. Y.; North Andover, Mass.; Omaha, Neb.; Kansas City, Mo.; Columbus, Ohio; Oklahoma City, Okla. Engineering Research Center, Princeton, N. J. Teletype Corporation, Skokie, Ill., and Little Rock, Ark. Also Western Electric distribution centers in 32 cities and installation headquarters in 16 cities. General headquarters: 195 Broadway, New York 7, N. Y.

and marine steam turbines have efficiencies of about 20 percent. As our most efficient units, large central station power plants have efficiencies of about 42 percent. At present, the efficiency of today's thermoelectric generators is constant at about 6 percent regardless of rating. Viewed from the standpoint of efficiency only, thermo-electric devices are thus comparable to conventional power sources in applications up to about 10 horsepower.

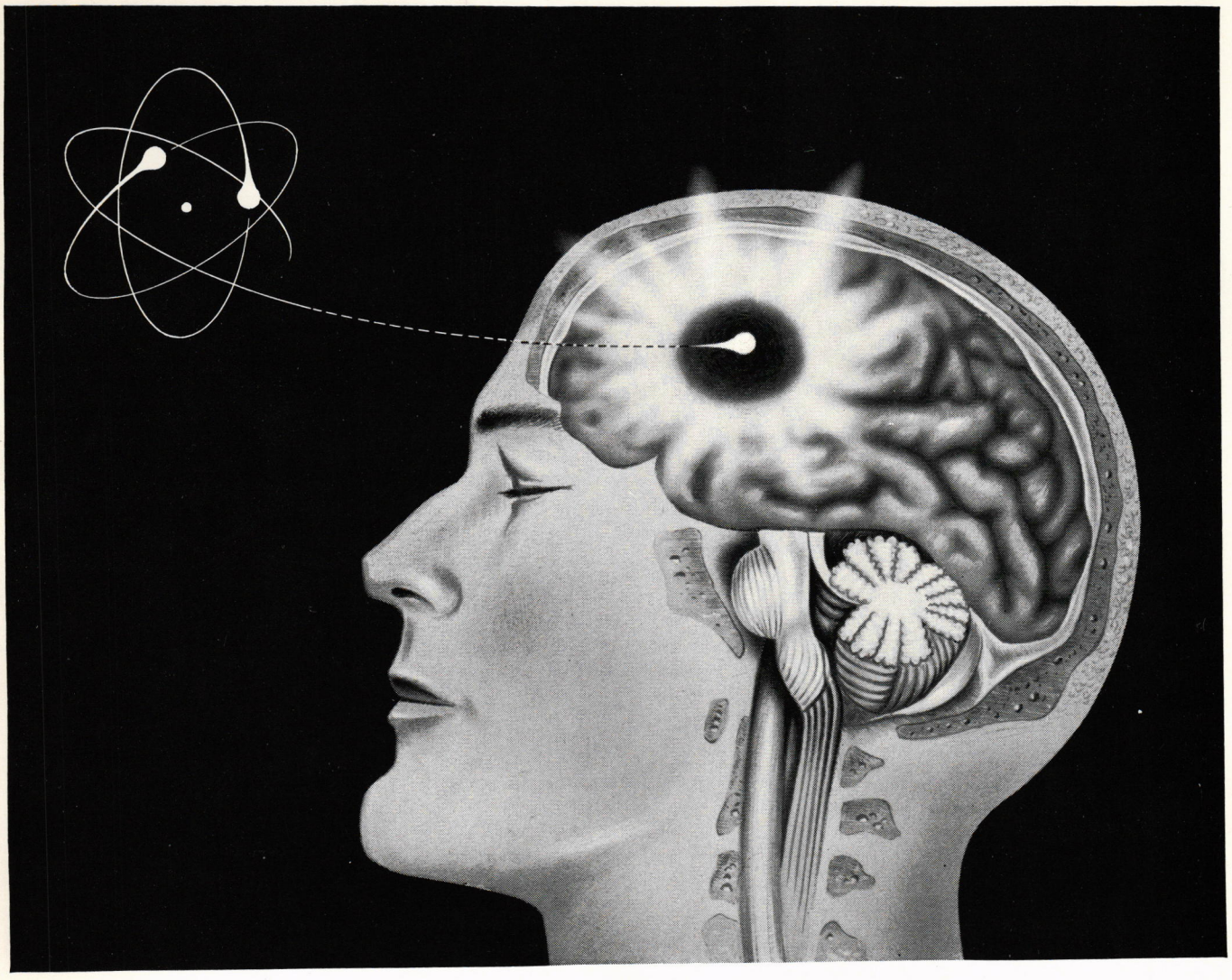
As new materials are developed, it seems likely that in about five years these materials will have an inherent efficiency of 30 percent. There is, however, no reason to regard this 30 percent as an ultimate ceiling. At the same time, it appears that to achieve efficiency much above this level a major breakthrough will be necessary. With 30-percent-efficient materials foreseeable in 1965, it will be feasible to construct generators with over-all efficiency of 20 percent, an efficiency level at which there would be many important applications for thermoelectric generators operating in the 1000-kilowatt range.

Projected Applications

In addition to certain military applications of thermoelectric generators which are expected to materialize, there are commercial applications that appear feasible in the near future. One of these is a thermoelectric power supply for communication and instrumentation equipment at locations along natural gas transmission lines in the many regions of the country where pipe lines and power lines are widely separated. Another similar application is thermoelectric power supplies for cathodic protection of oil well and pipeline equipment. Power requirements for such applications range from several watts to about 100 watts and are well within the capacity of today's technology.

Applications involving larger power levels will, of course, depend on an increase in the efficiency of thermoelectric power generation, but it is possible now to visualize thermoelectric power supplies in which a nuclear-reactor-energized thermoelectric generator included within the pile but equipped with external cooling loops would approach an over-all efficiency of 20 percent for ratings in the megawatt range.

Major problems lie before us, of course, before such applications are practical but we may be sure that thermoelectricity will be a very important element of the technology of the 1960's.



Boron-10 vs. brain tumors

Physicians and scientists working in cancer research at Brookhaven National Laboratory, Upton, N. Y., are probing the use of Boron-10 isotope in treating a common type of brain tumor (glioblastoma multiforme).

Results of this therapy are so encouraging that Brookhaven and at least two other institutions are constructing additional nuclear reactors used in this therapeutic venture.

The method. In a technique known as Neutron Capture Therapy, the patient receives an injection of a Boron-10 compound. Cancerous tissue absorbs most of the neutrons.

In the split second that the Boron-10 becomes radioactive, it produces short-ranged alpha particles which destroy cancerous tissue with a minimum of damage to healthy tissue.

Producing the isotope. The plant furnishing Boron-10 to Brookhaven ordinarily turns out about three pounds during a 24-hour work day. Separation of the isotope takes place in what is described as "the world's most efficient fractionating system." In 350 feet of total height, six series-connected Monel* nickel-copper alloy columns enrich a complex containing 18.8% Boron-10 isotope to one containing 92% Boron-10.

Purification. To purify the 92% concentrate, a whole series of complicated processing steps are needed . . . including deep freeze. Columns, reboilers, condensers, vessels, pumps, and piping abound—each a constant challenge . . . both to the metal and to those concerned with equipment design and operation.

How would <u>you</u> meet such challenges? Some problems, of course, were unique and demanded ingenuity of a high order. But answers to most, 90% or more, could be found in the vast "experience bank" maintained by Inco . . . some 300,000 indexed and cross-referenced reports of metal performance under all manner of conditions.

Make a mental note: (1) that The International Nickel Company is a rich source of information on high-temperature and corrosion-resisting alloys; (2) that Inco makes this experience available to you.

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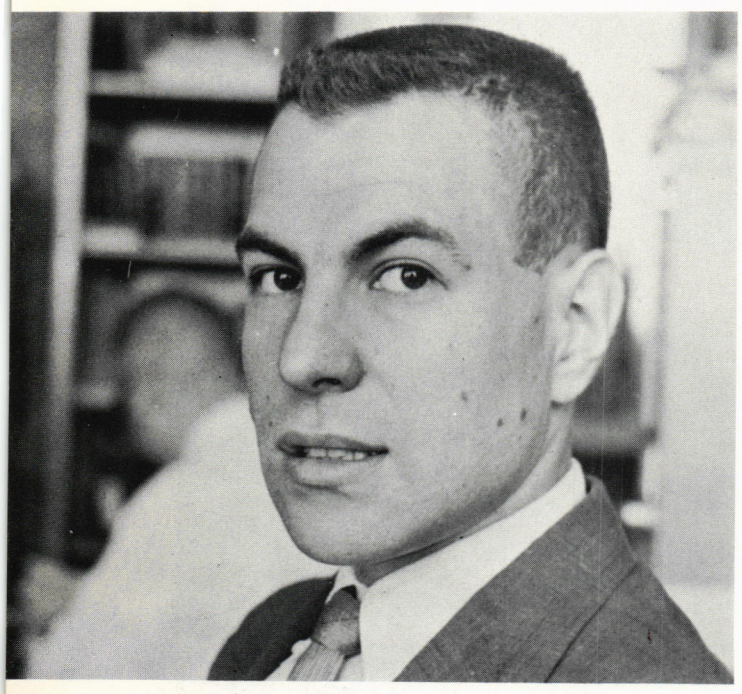
Faculty Page



Tompkins Hall is humming with the sound of machines running under the direction of Arnold C. Meltzer, the new instructor of energy conversion in the Engineering School.

Although he is a native New Yorker, he has lived in Washington, D. C., for the past fourteen years. His secondary schooling was completed at Anacostia High School. He was graduated from the George Washington University in 1958 with a B.S.E. degree and Computer Option. Mr. Meltzer gained practical experience working for the Federal Power Commission before his present teaching assignment.

This energetic faculty member is now working on his Master's thesis: A Study of Faraday Switches for Microwaves. He is a member of IRE. When not occupied with academic work he participates in sports car rallies.

Mr. George Luckyj (pronounced Lucky) was born February 28, 1927 in the Western Ukraine. He is married and has a four year old daughter. He has been employed in this area during the last ten years in structural and bridge design.

After seven years of night school, Mr. Luckyj received a Bachelor's Degree in Civil Engineering at The George Washington University. He is now working toward his Master's Degree at this university. He is a member of ASCE, Sigma Xi, and Sigma Epsilon.

Now a registered professional engineer in the District of Columbia, Mr. Luckyj is a consulting engineer for the Southwest Redevelopment Project designing port facilities and the Eleventh Street Bridge.

Our new mountain-top research laboratories ...where science will broaden steel's horizons

Now fast nearing completion, this huge research project is a multi-million-dollar investment in the future of steel. Few research facilities can boast the equipment planned for this one. And its magnificent 1000-acre site will provide a stimulating environment in which Bethlehem scientists will explore the unknown—in process and physical metallurgy; in mechanical and chemical engineering; in ceramics, chemistry, physics, and nuclear studies.

For college men this means opportunities in research, of course. And it also emphasizes progress in every phase of the steel business: preparation of raw materials; improved processing methods; new and better products.

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An Analog - Digital Differential Analyzer

The National Bureau of Standards has been investigating a proposed analog-digital differential analyzer that combines the analog advantages of high speed and continuous representation of variables with the digital capability for high precision and dynamic range. It represents dependent variables by two quantities, a digital number representing the more significant part, and an analog electrical voltage representing the less significant part.

Developed by H. K. Skramstad of the Bureau's data processing systems laboratory, the proposed analyzer appears to be naturally applicable in simulating the dynamic problems in missile or aircraft design studies. The addition of short digital registers and other digital components to an analog computer provides the increased precision required for solving such problems, while retaining the speed of the analog computer.

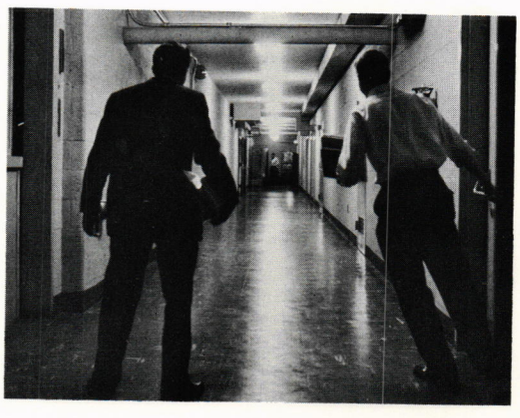
The electronic analog computer, although useful in solving dynamic problems described by differential equations, suffers from limitations of accuracy and dynamic range. The digital differential analyzer can provide any required degree of accuracy or dynamic range, but it can be relatively slow in operation and subject to possible instability of solution resulting from numerical representation of the variables and the use of finite different calculus in integration. Using both analog and digital techniques in a single analyzer makes it possible to combine the advantages of each for solving problems rapidly and with the desired level of precision.

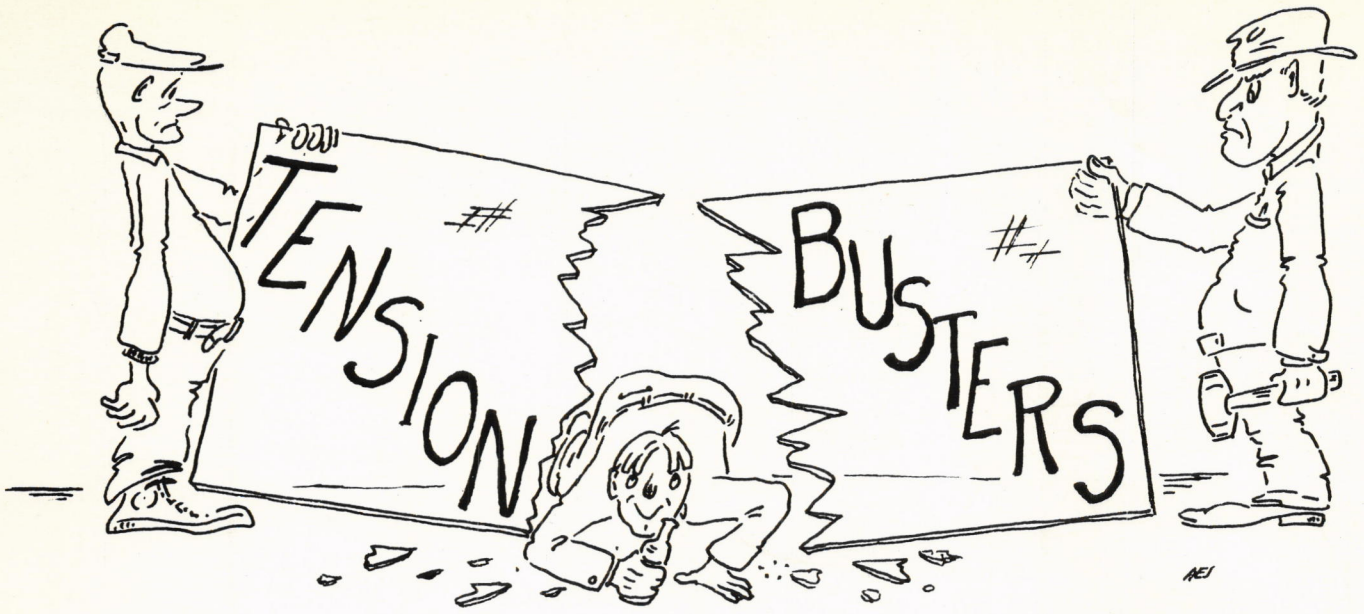
So far, an integrator and a multiplier have been designed. In general, they consist of one or more of the following units: an input digital register, a register for accumulating digital results, a digital-to-analog converter, a conventional analog integrator, a resettable analog integrator, an analog summer, and a comparator. These basic units can be constructed from electronic digital and analog circuits in present common usage. Analog-to-digital converters are not required for this system.

The over-all analyzer is designed so that the time period (Δt) during which the numbers in the digital registers do not change is made as small as possible, consistent with component limitations, in order to permit the maximum number of such periods. The greatest speed and precision are realized, of course, with the smallest Δt. However, Δt must be long enough not only to permit full-scale excursions of the various analog voltages, but also to fit within the bandwidth limitations of the operational amplifiers. Improvement in the characteristics of these units will help reduce Δt. Even with present components, it is estimated that the precision in solving problems can be increased by a factor of 10 to 100 over conventional analog methods.

Under the sponsorship of the Bureau of Naval Weapons, work has recently begun on the construction of breadboard models to evaluate the system. These circuits will contain 2 integrator and 2 multiplier units, each capable of receiving input voltages from other units. Digital registers and digital-to-analog converters will be constructed from transistorized digital packages, and the analog components from commercially available wide-band operational amplifiers. These units will have 8-bit plus sign input and accumulating registers, and an analog reference voltage of 10 v. They will operate with a Δt of 1 millisec or less.

WHAT'S MISSING?





A college graduate on his first job was handed a broom to sweep the floors for his first duty.

Grad: But, I'm a college graduate.

Employer: Oh, in that case I'll show you how.

★

A boy attending Sunday School for the first time, was being catechized by his teacher.

"Now, where does God live?" asked the teacher.

"I think he lives in our bathroom," chirped the youngster.

"Why do you think that?" gasped the teacher.

"Well, every morning daddy goes to the bathroom door and yells, 'God! are you still there'?"

★

Mother--"Freddie, have you seen your sister anywhere about?"

Freddie--"Yeah, she's out on the front porch naked."

Mother--"Goodness, you scared me. For a minute I thought you said necking."

★

The apple of a man's eye is usually a half-peeled peach.

★

Radio Announcer: "And now to get back to the game here at the colosseum. The score is now, Lions 20--Christians 0."

★

She: "Are you in the Army?"

He: "Sure."

She: "Did you get a commission?"

He: "Nope, straight salary."

★

Sentry: "Halt, who's there?"

Voice: "American."

Sentry: "Advance and recite the second verse of The Star Spangled Banner."

Voice: "I don't know it."

Sentry: "Proceed, American."

The day was warm, the hour was late.

But the editor's work all had to wait.

With nervous steps he paced the floor and look askance at the card he bore.

Then suddenly, quickly--a timorous rap!

With puzzled expression he answered the tap.

It was a frosh, with face scared and wet;

"I sent you a joke--did you get it yet?"

The editor groaned as he looked at the card . . .

"Not yet," he shrieked . . . "but I'm trying hard!"

★

Did you hear about the near-sighted professor who couldn't keep his pupils straight?

★

Professor--"This is the stadium."

Visitor--"Fine! Now take us through the curriculum. They say you have a fine one here."

★

A patent medicine manufacturing company received the following letter from a satisfied customer:

"I am very much pleased with your remedy. I had a wart on my chest, and after using six bottles of your medicine, it moved to my neck, and now I use it for a collar button."

★

Most girls are like parlor lights--out for a good time.

★

"Up and atom," cried the molecule.

★

First Coed: "George's mustache makes me laugh."

2nd Coed: "Tickles me too."

Drunk in telephone booth--Number, hell; I want my peanuts.

★

Student: "Is this ice-cream pure?"

Waiter: "As pure as the girl of your dreams."

Student: "Gimme a pack of cigarettes."

★

Overheard near campus: "I don't care what you're president of. Get your golf balls off my lawn."

★

One time I fell in love with a girl who was a twin. And it caused a lot of confusion, because both twins were the same size, coloring and weight. But I studied the twins carefully and finally got so that I could tell which one was Mary Jane and which one was Herman.

★

Six-year-old Johnny interrupted Mom as she was washing dishes in the kitchen.

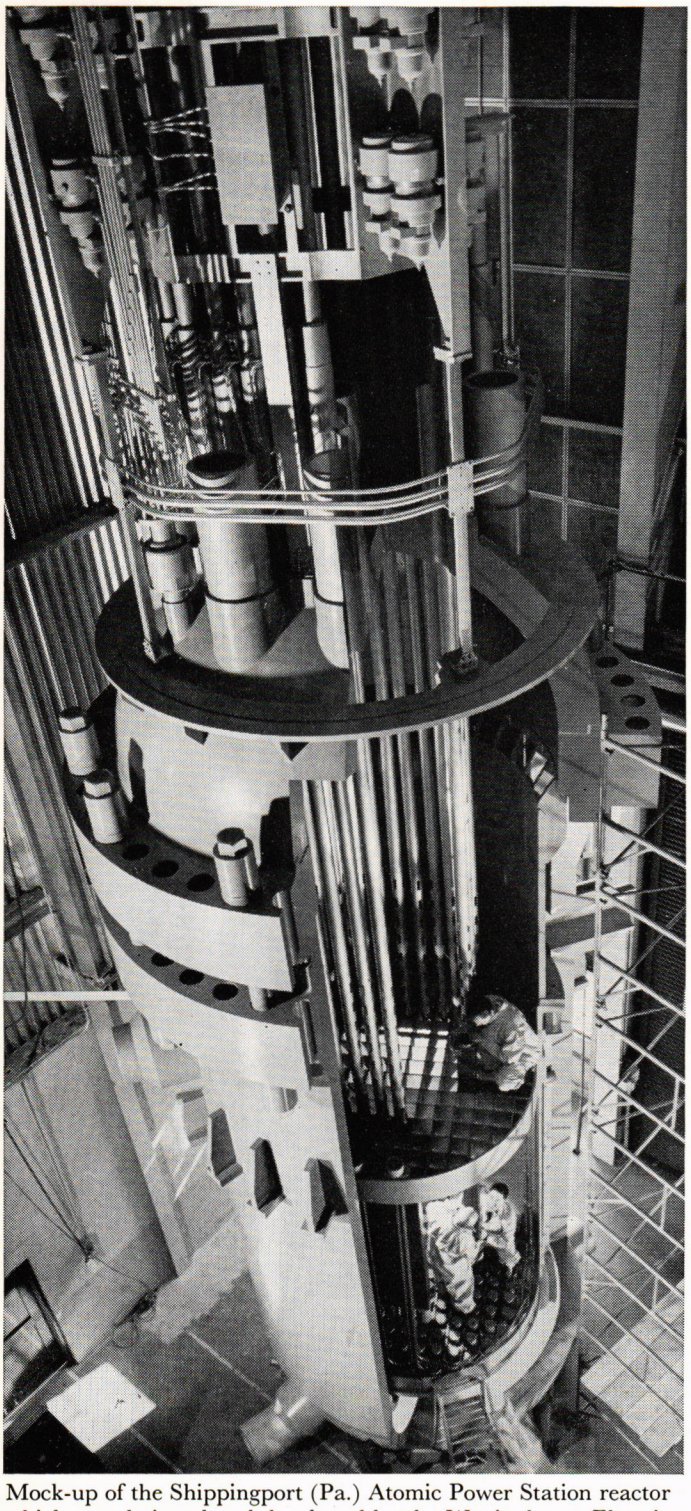
"Mom, didn't you say the baby had your eyes and Dad's nose?" he asked.

"Why, yes, Johnny," answered the mother, "Why do you ask?"

"Because you better watch him now. He's got Grandma's teeth."

★

If your sights are set  on nuclear power–



Mock-up of the Shippingport (Pa.) Atomic Power Station reactor which was designed and developed by the Westinghouse Electric Corporation under the direction of and in technical cooperation with the Naval Reactors Branch, U.S. Atomic Energy Commission.

–you'll find **Photography at Work** with you

Already engineers working with nuclear power have learned that only utmost purity of materials and meticulous accuracy in manufacture can be tolerated in a reactor. Steels for the reactors and reactor vessels are checked for make-up and molecular structure with photomicrography and x-ray diffraction. Welds are proved sound and moderators flawless with radiography. And stresses likely to occur are studied in advance with photo-elastic stress analysis.

In this new-day industry, as in any field on which you set your sights, photography plays a part in making a better product, in producing it easier, in selling it faster. It cuts costs and saves time all along the line.

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One of a series

Interview with
General Electric's Byron A. Case
Manager—Employee Compensation Service

Your Salary at General Electric

Several surveys indicate that salary is not the primary contributor to job satisfaction. Nevertheless, salary considerations will certainly play a big part in your evaluation of career opportunities. Perhaps an insight into the salary policies of a large employer of engineers like General Electric will help you focus your personal salary objectives.

Salary—a most individual and personal aspect of your job—is difficult to discuss in general terms. While recognizing this, Mr. Case has tried answering as directly as possible some of your questions concerning salary:

Q Mr. Case, what starting salary does your company pay graduate engineers?

A Well, you know as well as I that graduates' starting salaries are greatly influenced by the current demand for engineering talent. This demand establishes a range of "going rates" for engineering graduates which is no doubt widely known on your campus. Because General Electric seeks outstanding men, G-E starting salaries for these candidates lie in the upper part of the range of "going rates." And within General Electric's range of starting salaries, each candidate's ability and potential are carefully evaluated to determine his individual starting salary.

Q How do you go about evaluating my ability and potential value to your company?

A We evaluate each individual in the light of information available to us: type of degree; demonstrated scholarship; extra-curricular contributions; work experience; and personal qualities as appraised by interviewers and faculty members. These considerations determine where within G.E.'s current salary range the engineer's starting salary will be established.

Q When could I expect my first salary increase from General Electric and how much would it be?

A Whether a man is recruited for a specific job or for one of the principal training programs for engineers—the Engineering and Science Program, the Manufacturing Training Program, or the Technical Marketing Program—his individual performance and salary are reviewed at least once a year.

For engineers one year out of college, our recent experience indicates a first-year salary increase between 6 and 15 percent. This percentage spread reflects the individual's job performance and his demonstrated capacity to do more difficult work. So you see, salary adjustments reflect individual performance even at the earliest stages of professional development. And this emphasis on performance increases as experience and general competence increase.

Q How much can I expect to be making after five years with General Electric?

A As I just mentioned, ability has a sharply increasing influence on your salary, so you have a great deal of personal control over the answer to your question.

It may be helpful to look at the current salaries of all General Electric technical-college graduates who received their bachelor's degrees in 1954 (and now have five years' experience). Their current median salary, reflecting both merit and economic changes, is about 70 percent above the 1954 median starting rate. Current salaries for outstanding engineers from this class are more than double the 1954 median starting rates and, in some cases, are three or four times as great.

Q What kinds of benefit programs does your company offer, Mr. Case?

A Since I must be brief, I shall merely outline the many General Electric employee benefit programs. These include a liberal pension plan, insurance plans, an emergency aid plan, employee discounts, and educational assistance programs.

The General Electric Insurance Plan has been widely hailed as a "pace setter" in American industry. In addition to helping employees and their families meet ordinary medical expenses, the Plan also affords protection against the expenses of "catastrophic" accidents and illnesses which can wipe out personal savings and put a family deeply in debt. Additional coverages include life insurance, accidental death insurance, and maternity benefits.

Our newest plan is the Savings and Security Program which permits employees to invest up to six percent of their earnings in U.S. Savings Bonds or in combinations of Bonds and General Electric stock. These savings are supplemented by a Company Proportionate Payment equal to *50 percent* of the employee's investment, subject to a prescribed holding period.

If you would like a reprint of an informative article entitled, "How to Evaluate Job Offers" by Dr. L. E. Saline, write to Section 959-14, General Electric Co., Schenectady 5, New York.

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